

Performance Insight

Reorganising ATS with Virtual Centres



BACKGROUND

The PRC is in the process to establish a “Transformation Support Strategy” to drive the cooperation with stakeholders regarding the observed (and expected) performance enhancement from the modernisation of air navigation services in Europe. This includes the realised performance enhancement from emerging/novel operational concepts and associated enablers, but also entails “flagship” projects addressing specific capability gaps.

The latest developments in Europe in support to the modernisation of ATM led to the development of two important documents, the Airspace Architecture Study report, and the European ATM Master Plan. One of the key common elements of these strategic documents is to implement virtualisation, automation, and digitalisation of ATM.

For this purpose, the PRC has developed an initial scoping paper to analyse - in collaboration with key stakeholder (Skyguide and FINEST) - how ATM capacity and scalability will be impacted by the technical transformation process and new operational concepts, taking the example of virtualisation in general and virtual centres in particular.

NOTICE

The PRU has made every effort to ensure that the information and analysis contained in this document are as accurate and complete as possible. Should you find any errors or inconsistencies we would be grateful if you could please bring them to the PRU's attention by sending an email to: PRU-support@eurocontrol.int.



Growing capacity constraints

Air traffic growth has increased in recent years, reaching more than 11.1 million flights in the ECAC area in 2019 (i.e. 16.3 % more flights than in 2009).

Aviation has been hit hard by the COVID-19 pandemic and, even if traffic is close to recovering to 2019 levels in 2022, a slower growth than previously forecasted is expected for the future. Nonetheless, traffic will eventually exceed the pre-COVID levels which requires a preparation to accommodate the notably higher traffic levels while avoiding the high delay levels of 2018 and 2019.

According to EUROCONTROL's statistics and forecasts service (STATFOR), the most likely scenario suggests some 16 million flights in 2050 which corresponds to an additional 5 million flights compared to 2019.

ECAC	IFR flights			
	2019		2050	
	Total (million)	Avg. daily (thousands)	Total (million)	Avg. daily (thousands)
High scenario	11.1	30.4	19.6	53.6
Base scenario			16.0	43.7
Low scenario			13.2	36.2

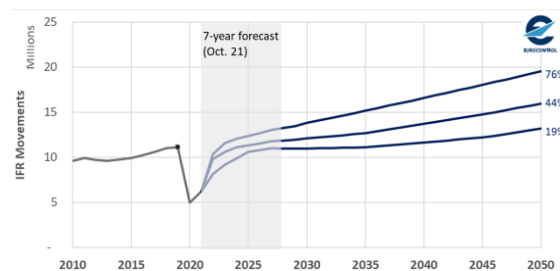


Fig. 1 ECAC area traffic forecast 2050 [1]

With air traffic continuing to grow, supporting sustainable capacity increase has become one of the main challenges for the ATM sector.

There are congestion issues across many areas of the European ATM network, leading in 2018/19 to the highest delays in the last decade. Capacity constraints have become a key challenge in some areas, and the situation is expected to deteriorate further in the coming years if changes supported by systems are not introduced to the

current airspace architecture, airport capacity and ATM operations.

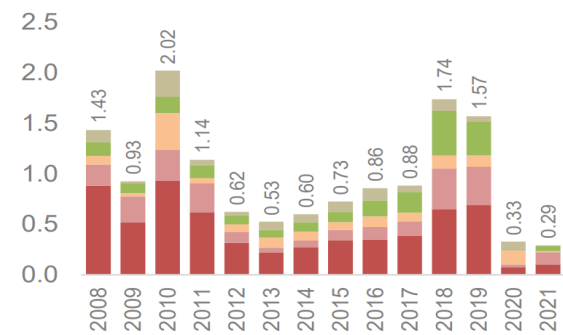


Fig. 2 Average en-route ATFM delay per min [2]



Factor limiting capacity. Lack of scalable capacity

Today, the ATM architecture in Europe is the result of historical operational and technical evolution conducted on a national basis and leading to an overall fragmented system [3]. The current architecture limits both the overall maximum capacity, as well as the scalability to meet changes and fluctuations in demand.

There are structural rigidities in the system that limit the ability to adapt capacity at short notice to meet changes in demand. One of the main constraints is the lack of flexibility in ATCO staffing, since controllers need to be trained on specific sectors. There are also limits to how many times sectors can be divided in order to increase capacity. On the demand side, airlines do not always operate strictly according to the flight plans that are filed which makes it challenging for ANSPs to plan the exact level of capacity needed.

As a result, ATC Capacity provision across the network tends to be more rigid than traffic demand. This results overall in spare capacity in some areas and excess load in other areas at the same time.

The best approach to face the challenges ahead is through effective collaboration between all ATM stakeholders including industry partners to define comprehensive ATM solutions aiming to achieve the objectives on increasing capacity, while ensuring business continuity, optimising cost efficiency, and improving environment sustainability.



Transformation strategy

In order to deal with these challenges, the Single European Sky vision already identifies different Operational and Technical building blocks that might change ATM operations and the automation of systems in the following years: e.g. free route, trajectory-based operations, flight/flow centric operations, interoperability, virtual centres, advanced HMIs, etc.

The latest developments in Europe in support to the modernisation of ATM led to the development of two important documents, the Airspace Architecture Study (AAS) [3] and the European ATM Master Plan, 2020 edition [4] whose subtitle is “Digitalising Europe’s Aviation Infrastructure”.

One of the key common elements of these strategic documents is to implement location independence, automation, and digitalisation of ATM, in particular, via Virtual Centres (VC).



Reorganising ATS with Virtual Centres

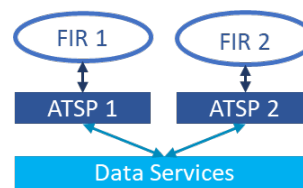
The AAS proposed the future Single European Airspace System, based on modern technologies that could divide the ATS provision from local infrastructure for data provision, enabling the decoupling of geographical location from the service provision.

As indicated in AAS, this decoupling would enable a virtualisation where service providers could use data from the common data services, opening doors to different organisation of ATS provision, namely more advanced capacity sharing. Also, the Transition Plan [5] indicates that this transition will require operational, technological, organisational and regulatory changes to the current airspace architecture.

With VCs, a new type of entity called ATM Data Service provider (ADSP) provides data services independent from the location. The study funded by the European Commission [6] presents the legal, economic and regulatory aspects to establish a common ADSP and capacity on-demand.

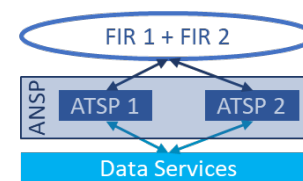
There are different options depending on the level of collaboration:

a) Shared Services



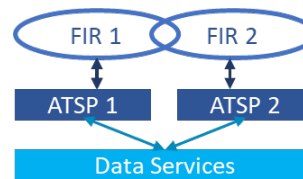
An ANSP subscribes to ATM data services from another ANSP, or both ANSPs using external ADSP as the main service or to support contingencies. This solution is being developed for example in ATM-data-as-a-service (**ADaaS**) [7]

b) Within an ANSP



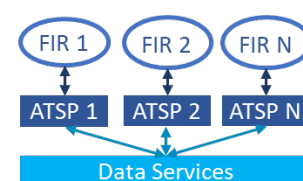
Applies to one ANSP operating more than one ATSU, so several ATSUs are served by the same ADSP as if they were one centre. This is very much the **SKYGUIDE virtual centre concept** [8].

c) Between neighbouring ANSPs



ANSPs collaborate in terms of temporary ATS delegations, opening sector on behalf of another ANSP that has insufficient resources. This type of solution is being developed by the **FINEST project in Finland and Estonia** [9] with significant cross-border cooperation.

d) Between ANSPs in a region



ATS delegation is enabled across multiple ANSPs in a region. In this option controllers are validated on the system rather than a sector, being able to control any sector anywhere. This option may require harmonization of operational concepts and procedures and significant increase in automation.

The last option is the most ambitious. In Europe, each ANSP has to build in capacity buffers to deal with peak traffic. Under this concept the buffers would only be needed at network level, reducing the cost of ATS and ATFM delays significantly.



Expectations of first VC deployments

SKYGUIDE virtual centre concept

With the Virtual Centre programme, Skyguide will harmonise and modernise from the technology on the ground to the operational procedures and the airspace design in the sky.

This new set-up, based on a network-centric and service-oriented architecture, allows to manage any piece of Swiss or delegated airspace from Zurich or Geneva as if there were only one air traffic service unit. This is called location independent management of an airspace.

The implementation started in 2014 and has delivered benefits already. It will be completed stepwise and produce full benefits by 2030.



Fig. 3 Skyguide Virtual Centre programme [8]

The Virtual Centre brings a number of benefits:

- It allows Skyguide to react much more rapidly to increasing or decreasing traffic demand by adapting the capacity as and where needed
- It thus makes ATM more efficient, resilient, scalable and less costly
- It contributes to limiting the environmental impact of aviation by enabling the optimisation of flight trajectories, which reduces CO2 emissions

- It strengthens business continuity capabilities with greater operational resilience and cyber security
- The technological harmonisation and modernisation foster the continuous improvement of the safety of air traffic operations
- More automation enables more traffic to be managed with less manpower than today

In operational terms Skyguide aims for:

- 20% operational productivity improvement
- 15% planned capacity increase in the sectors above FL245 and +5% in the sectors below FL245)
- En-route delay per flight below Performance Plan target
- Likelihood of clearance hazards reduced and more predictive safety tools
- En-route flight efficiency improved
- 10 MCHF annual savings from the new technology landscape

The Skyguide Virtual Centre programme is fully aligned with Europe's ambition of a digital European sky.

At the end a controller will work with a system managing the airspace location-independently which will require a competence-based system licence, rather than a geographic license. Once the system provides all relevant local information, it makes no difference anymore where the controller sits and which sector he or she is working.

Since 2018, Skyguide is operational with the new virtualized platform and has been migrating functionality step-by-step from the legacy environment to the new platform. The first system which was migrated was a critical capacity planning tool. In the meantime, Skyguide has integrated and virtualized safety critical systems and applications over the two centres. The process and procedure harmonisation between Zurich and Geneva centres was also a huge trust building step. The two ACCs are now close to 90% harmonised. Furthermore, the programme is introducing improved ATFCM predictive tools and automation initiatives to reduce the number of manual interactions. What is still missing are the system licences for ATCOs which will be the last piece of the mosaic.

FINEST project in Finland and Estonia

FINEST is a dynamic cross-border ATM programme by Estonian Air Navigation Services (EANS) and Fintraffic Air Navigation Services (Fintraffic ANS). It is the first of its kind in Europe to combine the airspaces of two countries and a poster child of the Single and Digital European Sky (SES) initiative, a joint venture across the EU aimed at building a shared digital European airspace by 2025.

Today Helsinki FIR is serviced from Helsinki ACC and Tallinn FIR is serviced from Tallinn ACC. With the realisation of the FINEST programme, a common airspace (Tallinn and Helsinki FIRs) F95+ will be serviced from the two ACCs.

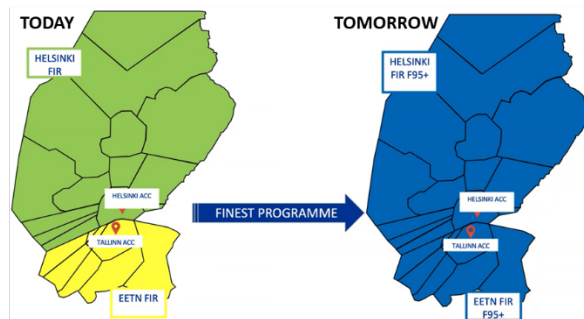


Fig. 4 FINEST project [9]

The airspace will be restructured, and new airspace segments will be established for enhancing the air traffic flows. The ATC sectors will be organised from certain airspace segments for supporting air traffic flows. The air traffic sectors in this airspace will be established on the basis of traffic flows, regardless of the national borders. The provision of air traffic services in sectors will be dynamically transferable between the ACCs (Area Control Centres) of Tallinn and Helsinki.

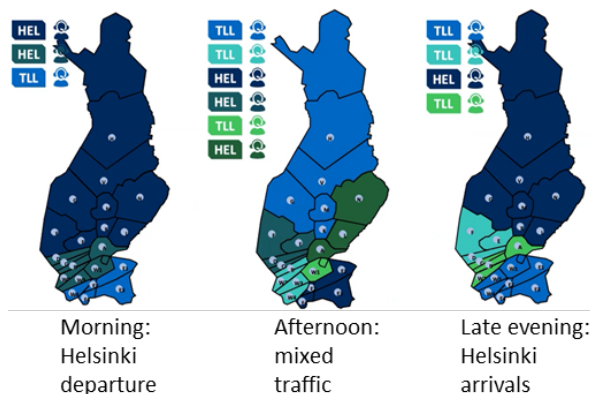


Fig. 5 Example of airspace design, its segments and traffic demand [9]

The FMP will create an operational sector by collapsing/splitting sectors to meet the actual traffic demand and flows. One licence and rating and one set of procedures allows using ATCOs throughout the FINEST area (Tallinn and Helsinki FIRs).

The objective of FINEST is to achieve optimal performance in the areas of service provision, cost-efficiency, capacity, flight efficiency, environment, and safety. It is a new reality with integrated FIR. The sustainable and digital way of providing safe services will provide cost efficient solutions to meet the customers' expectations, adapting the future traffic without extensively increasing resources.

FINEST will provide the possibility to fly shorter arrival/departures routes at main airports.

The FINEST goals and action plan are compliant with SES programme and SESAR the Deployment Plans regulatory framework. The goals of the programme are in line with the "Future Airspace Architecture Study" developed by the SESAR JU and the Network Manager. The support of the Network Manager and the industry is important for the implementation of the Deployment Plans.

A Multi-ANSP virtual centre allows to design and use sectors according to traffic flows instead of national borders. This would lead to:

- safer ATS (conflict points are in the centre of the sector and coordination to adjacent sectors becomes easier);
- enable more efficient trajectories (helps ATCOs to provide CDO/CCO);
- increase the overall capacity of FIRs (less workload in coordination, easier to solve conflicts, about +20%); and,
- increase the efficiency and capability to handle traffic demand with optimised resources (the total number of open consoles is less than the sum of open consoles in two ANSPs without the VC).

To implement any cross-border service provisioning or ADSP functionality, the European community has to address national restrictions on military flight data sharing. This would need to be solved at the European level.



SESAR R&D activities and deployment plan

The SESAR Programme has Virtual Centres as one of its areas of research. The focus [10] has been to demonstrate the technical feasibility of the decoupling of the air traffic controller's working position (CWPs) from the ATM data service provision, as an initial step to pave the way towards different business use cases and border uptake, enabled by SWIM applications.

In this initial stage, SESAR members have started to define open service interfaces that could be used across a wide area of network connections interoperable across air navigation service providers (ANSPs) and vendor independent ATC centre system solutions. The first results have been considered as promising in terms of increased flexibility in the organisation of ATC operations.



Fig. 6 Decoupling ATS from data service provision [11]

More specifically, the related SESAR Solutions/Activities for Virtualisation of Service Provision Operational change (focuses on En-Route and TMA environment) are listed below:

- Solution approaching Maturity (developed during SESAR 2020 Wave 1, concluding in 2019):
 - PJ.16-03 Enabling rationalisation of infrastructure using virtual centre-based technology.
- R&D Activities carried out during SESAR 2020 Wave 2 and Wave 3 of Industrial Research, both currently ongoing and planned to end in 2023:
 - PJ.10-W2-93 Delegation of services amongst ATSUs. This Solution has provided local benefits of 20% increase in flights per ATCO-hour on duty and 18%

increase in en-route capacity, during pre-industrial development maturity level exercises.

- PJ32-W3-VC Virtual Centres - Operational Thread.

These three Solutions are expected to reach an intermediate maturity at the end of the referred period, for which further research should be required to make them available for deployment.

SESAR activities will continue from 2023 in the so-called Digital European Sky (DES) Programme, whose Multiannual [12] and Biannual Work Programmes [13] identify the need to keep on prioritising Virtual Centres activities. This includes in particular calls for proposals on Digital Sky Demonstrators focused on new ATS business operating models and based on the delegation of ATC services using virtual centres. Specifically, the call addressing the “Virtual centres and ATM data service providers (ADSPs)” topic was published in September 2022, with expected kick-off of selected projects by mid-2023.

Simultaneously, the call for proposals of the first round of DES Industrial Research incorporates a working area on the European Master Plan Phase C (Capacity on demand and dynamic airspace Solutions), which includes the achievement of the necessary level of maturity to consider future deployment of the aforementioned SESAR Solutions.

Virtual Centres technologies are not included in the specific deployment plans issued by the SESAR Deployment Manager (SDM), as they don't appear in the CP1 (Common Project 1) Regulation. This is surprising considering the roadmap of research activities and the initiatives described in this paper.






Today SESAR has only a deployment plan for Enabling rationalisation of infrastructure using virtual centre-based technology (PJ.16-03). The rest of the solutions are still R&D Activities. SESAR expects benefits of Virtual centres to start in 2024 and full benefit to be delivered by 2032.





	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
PJ.16-03 Virtual centre	Start of deployment			End of deployment							
			Start of benefits							Full benefits achieved	

Fig. 7 SESAR Virtual centre deployment plan [14]

Key messages

The PRC is in favour of the development of a service-oriented architecture to address future capacity gaps. It will support the transformation process by ensuring an independent evaluation of set and achieved performance goals of emerging “flagship” projects such as Virtual Centres. It is an ongoing process and the PRC will continue to evaluate achieved versus expected benefits and document the results as part of the transformation support strategy.

Expected benefits of Virtual centres		
	Cost efficiency	<ul style="list-style-type: none"> Increased cost efficiency with the rationalisation and standardisation of systems and services, enabling ATC infrastructure and processes. Increased agility and cost efficiency to implement and commission new ATM functionalities throughout European ANSPs.
	Capacity	<ul style="list-style-type: none"> Harmonised ATM functionalities and seamless cross-border and cross-ATSUs transitions, enabling increased capacity. Increased flexibility through workload balancing between ATSUs. Increased capability for contingency planning.
	Flight Efficiency	<ul style="list-style-type: none"> Enable more efficient trajectories. Reduced en-route delays.
	Safety	<ul style="list-style-type: none"> Improved proactive safety indicators through greater predictive analytics.
	Resilience	<ul style="list-style-type: none"> Stronger business continuity capabilities with greater operational resilience and cyber security.

Most significant issues to develop Virtual Centre and how to address them		
	Regulation	<ul style="list-style-type: none"> Better interoperability and contingency - ANSPs have to be able to operate cross border which requires political willingness. Current regulation (373) contradicts modern technologies and thus the Master Plan (e.g. services versus equipment). Regulatory guidance and support must be much stronger. Better incentivisation and funding for early movers. The agreement on ATCO licenses requires support by regulators.
	Technical	<ul style="list-style-type: none"> Addressing the limited frequency issues is a major issue for Europe. Decommissioning legacy systems – the effort to decouple and re-engineer the legacy systems must not be underestimated.
	Coordination	<ul style="list-style-type: none"> At European level, e-coordination between ANSPs will be required. Agreement at state level for responsibility, liability, certification, oversight, and charges.
	Military	<ul style="list-style-type: none"> To implement any cross-border service provisioning or ADSP functionality. the European community must address national restrictions on military flight data sharing. This would need to be solved at the European level.

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